



Clio Dermatologica

Edited by Maurico Goihman-Yahr, MD, PhD

Historical perspectives of ethnobotany



Inayat Ur Rahman, MS^{a,b}, Aftab Afzal, PhD^{a,*}, Zafar Iqbal, PhD^a, Farhana Ijaz, MS^a, Niaz Ali, PhD^a, Muzammil Shah, MS^c, Sana Ullah, MS^d, Rainer W. Bussmann, PhD^{e,f}

^aDepartment of Botany, Hazara University, Mansehra, Pakistan

^bWilliam L. Brown Center, Missouri Botanical Garden, St. Louis, Missouri, USA

^cDepartment of Biological Sciences, King Abdulaziz University, Jeddah, Saudi Arabia

^dDepartment of Botany, University of Malakand, Malakand, Pakistan

^eSaving Knowledge, La Paz, Bolivia

^fMuseo Nacional de Historia Natural, Cota Cota, La Paz, Bolivia

Abstract Ethnobotany is the study of the direct interaction between plants and man in his culture. From time immemorial, man has been depending on Mother Nature for all his basic needs and plant diversity that existed around him always attracted his curiosity. Man's preliminary interest in plants started from his need for food, shelter, protection and then his attention shifted to the remedies for injuries and diseases. In fact, medicine and botany always had strong and close connections, as most of the modern medicines come from plant sources. The current venture reviews the developments and perspectives of ethnobotany in global scenarios. We have summarized the available literature and documentations regarding the historic background of ethnobotany. A survey of the literature survey reveals that plant resources were cited around the globe for curing almost all disease categories i.e. skin disorders, respiratory disorders, digestive disorders, urinary disorders, cardiac disorders, ophthalmic disorders, ear nose throat (ENT) disorders, excretory disorders, nervous disorders, immunity disorders and so on. The orally exchanged customary information/knowledge is in the hands of elders, and most of it can vanish after their deaths and could lead to the depletion of such imperative information. The ethnic society resources, like the folk asset in association with a nature of investigated and surveyed areas, can be conserved through documentation. The natural chemical compounds from plants may be screened and isolated. Plants with therapeutic uses should be tested in studies by using those isolated natural compounds in laboratories to screen and evaluate of plants metabolites with potential therapeutic uses.

© 2018 Elsevier Inc. All rights reserved.

Ethnobotany

The term ethnobotany was first used by the American botanist Dr. John William Hershberger, in 1895 during a lecture in Philadelphia to describe his research, which he described as

the study of "plants produced by primitive and indigenous peoples".¹ In 1896, Hershberger published the term and suggested "ethnobotany" as a field that addresses the cultural status of the tribes who used the plants for food, protection, medicine, clothing, hunting, ornamental, fencing, firewood, timber, food, agricultural tools, building materials, and religious ceremonies. Many researchers have defined Ethnobotany in different context. Ethnobotany was described as the

* Corresponding author.

E-mail address: aftabafzalkiani@yahoo.com (A. Afzal).

study of the direct interaction between man and plant population in their culture.² Ethnobotany is the study of the relationship between plants and humans: the term "ethno" refers to the study of people and "botany" to the study of plants.³ Ethnobotany is also defined as the study of interactions and relationships between plants and humans in time and space.⁴ Ethnobiology may be summed up in four words i.e. humans, plants, interactions, and use.⁵ The modern concept of ethnobotany⁶ has its roots in botany; in fact, medicine and botany always have strong and close connections and many of the modern medicines have plant origins. Ethnobotanists with additional knowledge and / or training in areas, such as archeology, chemistry, ecology, anthropology, linguistics, history, pharmacology, sociology, religion and mythology, have raised many interesting questions.⁷ For example, botanists with anthropologic and ecological understanding of plants consider them as an integral part of human culture. They not only study the plants or forests, but also work within particular indigenous cultures, studying the indigenous concepts of the culture.

Importance of ethnobotany

About 4.22 million flowering plants have been reported, and more than 50,000 are used worldwide for medicinal purposes.⁸ World Health Organization (WHO) has reported that 80% of the world's population is primarily dependent on indigenous medicine, with the majority of traditional therapies involving the use of plant extracts.⁹ According to WHO, three-quarters of the world's population cannot afford modern medicines and rely on traditional herbal medicines.¹⁰ Similarly, 252 primary care medicines that are considered essential, 11% have a plant origin.¹⁰ This scientific field offers a possibility for the reconstruction of cultural identities, from small human groups to large civilizations, through the retrospective evaluation of various historic uses such as food, wood, magical / religious purposes, and medical and fiber applications.¹¹ Even today, medicinal plants provide a cheap source of medicines for much of the world's population.

Plants will continue to provide directly applicable drugs as well as a wide variety of chemical compounds that can serve as a starting point for the synthesis of new drugs with improved pharmacological properties.¹² A study was conducted on the ethnobotany of *Ziziphus spina-christi* in the Middle East on various aspects. Historically, religiously, philosophically, linguistically and pharmacologically, among Muslims, Jews, and Christians, highlighting that this is the only tree considered holy, in addition to the status of a "sacred tree" by the Muslims, it also has a special status of a "blessed tree" in the Druze religion.¹³ Plants are considered the life blood of our ecosystem, providing not only our basic amenities like fuel, fodder, food, or even building materials, but also the elixir for treating or curing many conditions.¹⁴

Historical perspectives

From time immemorial, man has been depending on Mother Nature for all his basic needs and plant diversity always attracted his curiosity. Man's preliminary interest in plants started from his need for food, shelter and protection. Then he sought among them the remedies for injuries and diseases and this resulted in the science of medicine. The Rig Veda says that man learned to distinguish edible plants from poisonous plants by observing animals, which feed on different plants. Gradually, man then domesticated many of the wild plants for his basic needs. This domestication and large scale cultivation were the result of the identification of the immense potential uses of each plant. It was also the result of the constant man-plant interaction in the past.¹⁵

The use of plants and plant products as remedies have been known since the origin of human civilization. In other words, the use of medicinal plants as a source of relief and cure for various diseases is as old as mankind itself. From ancient times, plants have been indispensable sources of preventative and curative medical preparations for humans and animals. There are reports of medicinal plants that have traditionally been used since 5000 BCE in China¹⁶ and 1600 BC by Syrians, Babylonians, Hebrews, and Egyptians.¹⁷ In fact, the ancient Egyptians believed that medicinal plants were also useful in the afterlife of Pharaohs. The plants remains found in the Giza pyramids and are in a dark corner of the Access Resource Center in the Cairo Museum. Schultes¹⁸ mentions in his article has indicated to the ancient ethnobotanical formulations of the Sumerian ideograms that dates back to 4000 BC.

The history of the oldest civilization of the ancient cultures in Africa, China, Egypt, and Indus Valley indicates the use of herbal medicines.¹⁹ The first record of medicinal plants of Indo-Pak is found in Rig-Veda between 4500-1600 BC and Ayurveda 2500-600 BC.²⁰ These became the oldest repository of human knowledge and description of the 67 plants (Malla, Shakya). According to the Rigveda, Ayurveda (the foundation of the Science of Life and the Art of Hindu Culture Cure) revealed the importance of medicinal plants in 12th century. Ayurveda began in 2500 BC, the Greco-Arab Society contains many Ayurvedic theories and remedies that led to the founding of Unani.²¹ The Charak Samhita and Charaka (900 BC) and Susruta Samhita (500 BC) counts are surgery, therapy and medication in detail based on Atharvaveda.²² This system monitors its origins in Greek medicine, adopted by the Arabs, and then spreads to India and Europe.²⁰

In India, a brief reference to the documented knowledge regarding remedial assets of 99 plants can be traced back to the Vedic period dating back from 3500 to 1800 BCE. A more detailed account is available in the Atharvaveda, which deals with 288 medicinal plants. The oldest one is "Vruksha ayurveda", compiled by Parasara. The sacred Vedas i.e. "Rigveda" (1400-1800 BC), "Atharvaveda" (4500-2500 BC). According to Vedas, about 1000 years ago there was no information on the development of this science in India. Then, the two most important works of the Indian treatment system appeared: Charak and

Susrut's work, Charak Samhita and Susrut Samhita. It was in 377 CE, a Greek physician Hippocrates stated "Let your cure be your food and eat your medicines".²³ In 77 CE, the Greek Dioscorides published "De materia medica" a catalog of about 600 plant species found in the Mediterranean. It also contains information on how the Greeks used plants, especially for medical purposes.²⁴ Most of the pre-existing knowledge system was pre-determined with the use of traditional medicine in various countries.²⁵ Cultural healers in many parts of the world define life as an entity comprising of body, mind, and soul; their well-integrated functioning is reflected in physical, mental, and intellectual well-being. The Holy Prophet Hazrat Muhammad (PBUH) used some medications to treat various diseases.²⁶

Until the mid-19th century, plants were the major therapeutic agents used by humans, and their role in medicine remains relevant to this day.²⁷ In the mid-19th century, the residents of the Hawaiian Islands were devastated by the infection of *Mycobacterium leprae* the causal agent for disease called Hansen's disease or leprosy. During those days, the plant *Hydnocarpus kurzi* (Chalmogra) was brought to the islands, where 14 months trial of intravenous injection of chalmogra oil was conducted on the infected patients. The treatment showed the astonishingly positive results wherein, half of the patients recovered from the disease.²⁸

In the late 19th century, ethnobotany began to develop as a science that offered new tools for pharmaceutical research. Public institutions, such as the WHO, and private pharmaceutical companies have begun to invest in ethnobotanical expeditions.²⁹ The use of historical documents is of utmost importance to obtain information that suggests the relationship between people and environment in the past. The discovery or retrieval of information from manuscripts, books or other sources promotes a sequence of plant utilization evolution, for example in the issue of disease concepts and culture forms.³⁰

Indian subcontinent

The documentation of ethnobotanical use of plants is found on the Indian subcontinent, a variety of uses for plants in worship, medicine, food, fuel and as agricultural tools is mentioned in Indian literature and in Hindus' religious books (4000 and 400 BCE) i.e. Rigveda, Atharvaveda, Upanishads, Mahabharata and Puranas.³¹ Although, the concepts of ethnobotany were well explained in 1870s, the elements of this science were evident in India much before that.³² From 16th century onwards, non-Indian workers took a firm rein in active herbal study. Thomas Rives, Odardo Verbosa, Cristobal de Costa and Garcia de Orta are the most prominent figures of these early stages. Garcia de Orta³³ published a book '*Coloquios dos simples e drogas e cusas medicinas da India*'. It documented about 50 common taxa of medicinal significance and other utilities as gathered around Goa and in Malabar. Interestingly,

it is in the form of a dialogue between the author and Spanish fictitious Doctor Rauno. This is truly the first book in printed form on Indian plant species especially with line drawings. It is not only a milestone in the history of 'Ethnobotany' or 'Botany', but also a landmark for the science of Pharmacognosy in Indian context.¹⁴ Early Indian works like the catalogue of Indian medicinal plants and drugs,³⁴ *Materia Medica of Hindoostan*,²⁰ dealt mainly with plants and drugs of established indigenous systems of Indian medicine.

British rule (1858-1947)

The 18th century indicated some of the most outstanding contributions based on researches on modern lines, which practically forged a strong foundation for the later years of investigations. Out of these, major works may be accredited to Ainslie, 1813 and O'Shaughnessy and Wallich, 1844. At the end of 18th century, the Indian investigators saw two major works in *Hindu Materia Medica* (Dutt, 1870) and *Indigenous Drugs of India*.¹⁴ The record of the very first Indian medicinal plant is *Soma* being used by Indo- Aryans; however, its correct equivalent nomenclature in the present day is a matter of confusion because the plant is referred in literature by their common names and some twenty different plant species have been attributed to this name, varying from plants like *Sarco stemma* (a flowering plant) to *Amanita muscaria* (a fungus), even then many specialist today presumes it to be *Ephedra pachyclade*.³⁵ The science of ethnobotany began taking shape during the British regime. They surveyed wild and cultivated plants as a part of their floristic/botanical studies. Roxburgh³⁶ during his floristic investigations particularly in South India, noted medicinal uses of herbs, apart from their botanical identification and vernacular names. Beginning in 1873, Sir George Watt studied economically important plant species especially in Manipur. He published 'Dictionary of the Economic Products of India' (1889-1896) and "The Commercial Products of India" (1908). In the former Dictionary, he provided nearly 3000 local names of plant products and their uses as obtained from various regions of India.²⁰ He also equated these names with important Indian languages and even tribal dialects. In addition, great attention was paid to the sacred plants. His work is not only a monumental but also reflects true "Ethnobotany" and indigenous knowledge of the Indian societies. Later, plants used as medicines by Santal tribe were published.³⁷⁻³⁹ These were published in Memoirs of Asiatic Society of Bengal, this work was revived⁴⁰ after Indian Independence.⁴¹ The information of catalogues, dispensaries, pharmacopoeias and illustrations of plants with notes on medicinal uses published in the 19th century by Watt's (1889-1896) in six-volumes Dictionary of Economic Products.^{42,43} Undoubtedly, the subcontinent has a very long socio-cultural history and heritage and the local communities throughout India preserved the instinctive knowledge of medicinal uses.⁴⁴

Post-independence era of India

The presence of multiethnic groups and diverse vegetation of angiosperms alone (over 20,000 species) makes India one of the hotspot of Ethnobotanical knowledge. Studies conducted as part of All India Co-ordinate Research Project on Ethnobiology revealed that the tribes of India use over 9,500 wild plant species for meeting various necessities. They use 7,500 wild plant species for medicinal purpose, 3,900 species for food, 525 species for cordage and fiber, 400 species for fodder, about 300 species as pesticides, 300 species as gums, resins and dyes, 100 species for incense and perfumes and 700 species for cultural and other requirements.⁴⁵

Organized ethnobotanical studies in India were initiated by Jain and his associates who carried out ethnobotanical studies among the tribes of Central India, Madhya Pradesh.^{31–39,46–52} The ethnobotanical knowledge of plant species was collected and interviews were taken from different tribal men.⁵² An ethnobotanical survey was carried out and eleven plant species curing various disorders in Pichavaram mangroves, Tamil Nadu, India.⁵³ In an ethnomedicinal study,⁵⁴ reported 281 species belonging to 108 different families are used in the folk medicine of Darjeeling Himalaya; however, 14% of the medicinal plants of this area are under threatened condition. A survey was conducted on the traditional uses of medicinal plants by Jantia tribe in India.⁵⁵ They reported 39 medicinal plants species belonging to 27 families with 39 genera used to cure different disorders. A survey was carried out for the uses of medicinal plants by the tribal people of Purandharin Maharashtra, India.⁵⁶ This report revealed 77 plant species belonging to 30 families of medicinal plants, which were cited for curing cough, asthma, diabetes, diphtheria, snake bite, and scorpion bite etc. Another survey reported on reported the plant uses among indigenous of Sariska and Siliserh regions of Alwar, District Rajasthan, India⁵⁷ which documented 110 species of plants used for diseases.

Post-independence era of Pakistan

About 6000 species of flowering plants have been identified and documented in Pakistan, and among these more than 600 plant species are identified as having medicinal values.^{58,59} The flora of Pakistan is very rich with unique biodiversity due to its diverse climate, soil conditions, and diverse ecologic regions,⁶⁰ though scattered over a large area.⁶¹ Pakistan has a rich history on the folk uses of plants. In the early 1950's, more than 80% of Pakistan's population was totally dependent on ethnomedicines for traditional medicinal health practices.^{62,63}

Traditional Unani medicines depend on medicinal plants, other than animals and minerals,⁶⁴ and this healthcare system is part of the Pakistani culture. Pakistan is one of the countries where traditional Unani medicine is used by large segments of the population. Unani medical system originated in the ancient

Greek and is documented by the period of Islamic civilization. Unani's medical system was brought to the Sub-continent by Muslim scholars and took it for centuries.²⁰

This traditional knowledge was only practiced in rural areas,⁶⁵ but due to its economic values, it has expanded.⁶⁶ In a study, 87 plants along with their traditional uses are mentioned from the upper Guraiz and Astore Valley, Gilgit Baltistan.⁶⁷ Similarly, hundreds of medicinal plants of West Pakistan with their descriptions, constituents, and uses are documented.⁶⁸ More recently, another survey was carried out on ethnobotany in Pakistan and reported 95 species used for curing various diseases.⁶⁹ Sixty-seven medicinal plants were enlisted from Khyber Agency, Pakistan.⁷⁰ In this report,⁷¹ fifty-two medicinal plant species were cited as traditionally used medicine. A study was conducted in Balochistan province, and 14 plant species were collected with their local ethnobotanical usage.⁷² Another survey was carried out in the Mansehra District, 53 wild and 17 cultivated medicinal plants with their local uses were documented.⁷³ Fifty-nine medicinal plant species were cited by the local informants as insecticidal agents.⁷⁴ In an ethnobotanical survey,⁷⁵ 140 plants were collected from Dabargai Hills, Swat. Out of these, 125 plants species were cited for various economic purposes. Ethnobotanical information of 79 plant species was gathered from the Upper Siran Valley.⁷⁶ These plants were used for various purposes by the local people i.e. for medicinal, fodder, food, shelter, ornamental. *Taxus baccata* cited by the local informants used as antispasmodic, insecticidal, and sedative.⁷⁷

Fifty herbaceous plant species were used as medicine by inhabitants of Margalla Hills National Islamabad.⁶¹ A survey was conducted in Margalla Hills, where the community members used dried roots of *Berberis lycium* to cure mouth disease locally known as "Chall" and bone fractures.⁷⁸ Kahuta (Rawalpindi) was surveyed, and 25 medicinal plant species were collected, which were being used as medicine.⁷⁹ *Pongamia pinnata* oil was reported helpful against herpetic and eczematous lesions and *Euphorbia helioscopia* against rapid dog bites.

The ethnobotany of Bunner District was studied, where the local inhabitants rely on medicinal plants for curing thirty different diseases.⁸⁰ Forty-one plant species were cited by the local people for curing various infectious diseases in Chapursan Valley.⁸¹ The cultural medicinal uses of 15 weed species for diversification and their botanical description was gathered and documented from district Attock.⁸² In total, 95 medicinal plant species belonging to 38 families along with its traditional uses were recorded from Samahni Valley, Azad Jammu Kashmir.⁸³

Indigenous knowledge of local informants regarding the uses of 45 plants was recorded from Hattar region, District Haripur.⁸⁴ Forty-three plants belonging to 33 families used for various purposes (i.e. for food, shelter, fodder, timber wood, fuel wood, and health care) collected and documented from Ratwal Village, District Attock.⁸⁵ In total, 97 plant species were used by native people of Bhera, District Sargodha.⁸⁶

Out of these, 84 species, were used as fodder, followed by medicine (78 spp.), food and fruits (46 spp. each), fuel wood (20 ornamental (18 spp.) and timber wood (7 spp). A survey of medicinal flora of Hingol National Park (Baluchistan) was conducted and 30 species were cited by the residents for treating various diseases.⁸⁷

The ethnobotanical knowledge of plant resources in Mangowal (Gujrat) was recorded, where 40 plant species were used by the locals for curing different ailments *i.e.* asthma, pile, skin diseases, stomach pain, and ulcers.⁸⁸ In a survey,⁸⁹ 107 ethnomedicinal plants were collected from the war affected region of Northwest, Pakistan.

An ethnomedicinal survey of Tehsil Kabal, District Swat, Khyber Pakhtunkhwa province was carried out, and 45 plants were reported as medicinal species.⁹⁰ Two hundred and fifty plant species were used by local communities of Basikhel Tribe (District Tor Ghar) for 23 different categories like timber, food, fodder, medicine and agricultural implements.⁹¹ A survey on traditional medicinal flora of Sarban Hills, District Abbottabad was conducted and 74 plants were found important for curing 56 various diseases where, the most commonly treated diseases were cough, digestive disorders, pain and skin diseases.⁴

Manoor Valley was surveyed and 44 medicinal plant species documented to cure 26 different stomach disorders.⁹² Similarly, in another study,^{93,94} 25 plant species were cited against dental disorders by the community members of Manoor Valley, Pakistan. A survey was carried out based on the uses of plants mentioned by the locals of Bajaur Agency, Federally Administered Tribal Areas of Pakistan, where 79 species were used for treating different ailments.⁹⁵ Fifty-one plants were locally utilized for the cure of various diseases in Deusai plateau (Gilgit), Pakistan.⁹⁶

Rewards and compensation to cultural drivers

Anthropologist Darrell Posey states that natives who provide data must be repaid. He stresses that money-related remuneration is utilized to protect the land, the general population, and their societies. Without remuneration, the information/knowledge of local societies will be lost because societies are under threat of elimination unless they can secure the money related intends to hold control of their fate. As cultural knowledge is lost through assimilation, the general population will be drawn into damaging the Western methods for utilizing the environment, for example, clear-cutting for logging and dairy cattle fields/meadows. Keeping in mind the end goal to survive, local groups will be constrained into decimating the condition that has supported them.

Conclusions

Ethnobotany as a science is on the rise globally, still the attention paid or research facilities acquired for it are far below

other molecular or sub-atomic research. Field ethnobotanists have not yet received a similar level of funds and regard, essentially in light of the fact that enthusiasm for this field has just barely reemerged; however, the field is developing. Highly esteemed scientific journals have started to spread the investigations of the ethnobotanists to peers, different researchers, and policymakers around the world. Due to expanded open intrigue and strategy making in preservation, organizations are seeking plants for new ways to deal with sustenance, food, drugs, and vitality sources. The orally exchanged customary information/knowledge is in hands of the elders, and most of it can disappear after their death due to which such imperative information may get vanished. The ethnic society resources, like the folk asset in association with a nature of investigated and surveyed areas, can be greatly conserved through documentation. The natural chemical compounds may be screened and isolated. Plants with therapeutic uses must be tested in studies by using those isolated natural compounds in the laboratories (which may incorporate High-Pressure Liquid Chromatography and *in vivo* transgenic animals experimentations) to decide and screen the metabolites of plants for possible therapeutic uses.

Acknowledgment

The Higher Education Commission (HEC), Pakistan provided the scholarship under International Research Support Initiative Program (IRSIP) to conduct research at Missouri Botanical Garden, USA.

References

1. Ali ASA, Beg H, Dasti AA, et al. Ethnobotanical studies on some medicinal plants of Booni valley, district Chitral Pakistan. *Pak J Weed Sci Res.* 2006;12:183-190.
2. Pei S. Ethnobotany and sustainable use of plant resource in the HKH Mountain Region. Planning workshop on ethnobotany and its application to Conservation and community development in the Hindu Khush Himalayan (HKH), Nepal; 1995.
3. Martin JR. Sense and sensibility: texturing evaluation. In: Foley J, ed. *New Perspectives on Education and Discourse*. London: Cassell; 2004. p. 452.
4. Ijaz F, Iqbal Z, Rahman IU, et al. Investigation of traditional medicinal floral knowledge of Sarban Hills, Abbottabad, KP, Pakistan. *J Ethnopharmacol.* 2016;179:208-233. 455.
5. Ijaz F, Iqbal Z, Rahman IU, et al. People-plants interaction and its uses: a science of four words "ethnobotany". *Altern Integr Med.* 2017;6:1.
6. Aumeerud Y. Ethnobotany, linkages with conservation and development. Proceeding of first training workshop on Ethnobotany and its applications to conservation NARC, Islamabad; 1996. p. 152-157.
7. The iamshaman shop. <https://www.iamshaman.com>.
8. Walter W, Hamilton A. *The Vital Wealth of Plants*. London: Bates and Sons Ltd.. 1993.
9. Azaizeh H, Fulder S, Khalil K, et al. Ethno medicinal knowledge of local Arab practitioners in the Middle East Region. *Fitoterapia.* 2003;74:98-108.
10. Ansari JA, Inamdar NN. The promise of traditional medicines. *Int J Pharmacol.* 2010;6:808-812.
11. Norton HH. Plant use in Kaigani Haida culture: correction of an ethnohistorical oversight. *Econ Bot.* 1981;4:434-449.

12. Potterat O, Hostettmann K. Plant sources of natural drugs and compounds. In: Nierenberg WA, ed. *Encyclopedia of Environmental Biology*. London: Academic Press; 1995. p. 139-153.
13. Dafni A, Levy S, Lev E. The ethnobotany of Christ's Thorn Jujube (*Ziziphus spina-christi*) in Israel. *J Ethnobiol Ethnomed*. 2005;1:8.
14. Dikshit SS, Rai SI, Sharma MM. Saga of ethnobotanical genesis from ancient to present scenario with special reference to the Darjeeling Himalayas. *J Med Plants Stud*. 2016;4:108-116.
15. Schultz RE, Raffauf RF. *The Healing Forest: Medicinal and Toxic Plants of the Northwest Amazonia*. Portland, OR: Dioscorides Press. 1990.
16. Wang M-W, Hao X, Chen K. Biological screening of natural products and drug innovation in China. *Phil Trans R Soc*. 2007;362:1093-1115.
17. Dery BB, Ofsynia R, Ngatigwa C. *Indigenous Knowledge of Medicinal Trees and Setting Priorities for Their Domestication in Shinyanga region*. Tanzania Nairobi, Kenya: International Center for Research in Agroforestry. 1994.
18. Schultes RE. Topping our heritage of ethnobotanical lore. *Econ Bot*. 1960;14:257-262.
19. Baqar SR. *Text Book of Economic Botany*. Karachi: Ferozsons Ltd. 2001: 23-100.
20. Ahmed J. Floristic diversity and ethnobotanical appraisal of Tehsil Oghi, District Mansehra, Pakistan. M.Sc. Thesis (Botany) Mansehra, Pakistan: Govt. Post Graduate College. 2017.
21. Hamayun M. Studies on ethnobotany, conservation and plant biodiversity of Utror and Gabral Valleys District Swat, Pakistan. Ph.D. Thesis Islamabad, Pakistan: Department of Plant Sciences, Quaid-I-Azam University. 2005.
22. Nambiar VPK. Improved harvesting, processing and storage of medicinal plants: their role in conservation and quality of plant based drugs. In: Bhattarai N, Karki M, eds. *Proc. of Sharing Local and National Experience in Conservation of Medicinal and Aromatic Plants in South Asia*. HMG, IDRC, and MAPPA; 2002. p. 42-45.
23. Bartram W. William Bartram on the southeastern Indians. In: Braund KEL, ed. *Wasselkov GA*. Lincoln: University of Nebraska Press; 1995.
24. Acharya D, Anshu S. *Indigenous Herbal Medicines: Tribal Formulations and Traditional Herbal Practices*. Jaipur, India: Aavishkar Publishers. 2008:440.
25. Farnsworth NR. Ethnopharmacology and drug development. Ethnobotany and the Search for New Drugs. Ciba Foundation Symposium, Nairobi, Kenya. International Center for Research in Agroforestry Prance. GT: John Wiley and Sons; 1999. p. 42-59.
26. Baqar SR. *Medicinal Plants and Poisonous Plants of Pakistan*. Karachi, Pakistan: Printers. 1989.
27. Camejo-Rodrigues J, Ascensão L, Bonet MÀ, et al. An ethnobotanical study of medicinal and aromatic plants in the Natural Park of "Serra de S.o Mamede" (Portugal). *J Ethnopharmacol*. 2003;89:199-209.
28. Parascandola J. *Chalmogra: oil and the treatment of leprosy*. Rockville, MD: Public Health Service Historian. 2003:18-23.
29. Chadwick DJ, Marsh J, eds. *Ethnobotany and the search for new drugs*, CIBA Foundation Symposium. Chichester, UK: John Wiley and Sons; 1994. p. 280.
30. Barbera GF, Carimi F, Inglese P. Physical, morphological and chemical changes during fruit development and ripening in three cultivars of prickly pear, *Opuntia Ficus-indica* (L.) Miller. *J Hort Sci*. 1992;67:307-312.
31. Jain AK, Mao J. Neural networks and pattern recognition. In: Zurada JM, Marks RJ, Robinson CJ, eds. *Computational Intelligence: Imitating Life*. New York: IEEE Press; 1994. p. 194-212.
32. Powers S. Aboriginal botany. *Calif Acad Sci Proc*. 1873-1875;5:373-379.
33. de Carvalho TN. Invisible travelers and virtual tracks: knowledge construction in Colóquios dos Simples e Drogas da Índia of Garcia de Orta (Goa, 1563). In: Roca-Rosell A, ed. *Proceedings of the 4th ESHS Conference*, Barcelona; 2010. p. 288-293.
34. Fleming J. A Catalogue of Indian Medicinal Plants and Drugs, with Their Names in the Hindusta'ni and Sanscrit Languages. *Asiatick Res*. 1812;11: 160. 153-96.
35. Trivedi P, Pandey A. Application of immobilized cells of *Pseudomonas putida* to solubilize insoluble phosphate in broth and soil conditions. *J Plant Nutr Soil Sci*. 2007;170:629-631.
36. Roxburgh W. *Flora Indica: Or, Descriptions of Indian Plants*. Reprinted Literatim from Carey's Edition of 1832. Thacker, Spink; 1874.
37. Bodding PO. Studies in Santal medicine and connected Folk lore—I. The Santals and disease. *Mem Asiat Soc Bengal*. 1925;10:1-132.
38. Bodding PO. Studies in Santal medicine and connected Folk lore—II. Santal medicine. *Mem Asiat Soc Bengal*. 1927;10:133-426.
39. Bodding PO. Studies in Santal medicine and connected Folk lore. *Mem Royal Asiat Soc Bengal*. 1940;10:427-502.
40. Jain SK, Tarafder CR. Medicinal plant lore of the Santhals. *Econ Bot*. 1970;24:241-278.
41. Shankar R, Bhattacharjee A, Jain M. Transcriptome analysis in different rice cultivars provides novel insights into desiccation and salinity stress responses. *Sci Rep*. 2016;6:23719.
42. Mitra R, Jain SK. Medicinal plant research in India. An overview. *Ethanobotany*. 1991;3:65-77.
43. Bangladesh Ethnobotany Online Database. www.ebbd.info/history-of-ethnobotany.html.
44. Shodhganga: A Reservoir of Indian Theses. http://shodhganga.inflibnet.ac.in/bitstream/10603/110249/1/1111_chapter%203.pdf.
45. Arunachalam V. *Indigenous Knowledge and Intellectual Property Rights: The Latent Logistics and the Overt Concerns*. 2002.
46. Jain SK. Ethnobotany, its scope and study. *Indian Museum Bull*. 1967;2.
47. Jain SK, ed. *Glimpses of Indian Ethno Botany*. New Delhi: Oxford and IBH Publishing Co.; 1981.
48. Jain SK, Mudgal V, Banerjee DK, et al. *Bibliography of Ethnobotany*. Howrah: Botanical Survey of India. 1984.
49. Jain SK. *Directory of Indian Folkmedicine and Ethnobotany*. New Delhi: Deep Publications. 1991.
50. Jain AK. Tattooing therapy among Sahariya tribal of Central India. *Ethnobotany*. 1995;7.
51. Jain S. Ethnobotanical diversity in Zingibers of India. *Ethnobotany*. 1995;7.
52. Jain SK, Sikanvar LS. *Some herbs less known for reproductive and child healthcare in India*. Patna: South East Asian Seminar on Herbs and Herbal Medicines. 1999.
53. Ravindran KC, Venkatesan K, Balakrishana T. Ethnobotanical studies of pichavaram mangroves of East coast, Tamil Nadu. *Ind J Tradit Knowl*. 2005;4.
54. Chhetri DR, Basnet D, Chiu PF, et al. Current status of ethnomedicinal plants in the Darjeeling Himalaya. *Curr Sci*. 2005;89:264-268.
55. Sajem AL, Gosai K. Traditional use of medicinal plants by the Jaintia tribes in North Cachar Hills district of Assam, Northeast India. *J Ethnobiol Ethnomed*. 2006;2:33.
56. Bhosle SV, Ghule VP, Aundhe DJ, et al. Ethnomedicinal knowledge of plants used by the tribal people of Purandhar in Maharashtra, India. *Ethnobot Leaflets*. 2009;2009:3.
57. Jain SC, Jain R, Singh R. Ethnobotanical survey of Sariska and Siliserh regions from Alwar district of Rajasthan, India. *Ethnobot Leaflets*. 2009;2009:21.
58. Nasir E, Ali SI. *Flora of Pakistan*. Islamabad: Pakistan Agriculture Research Council. 1971-1994.
59. Shinwari ZK, Khan BA, Khan AA. *Proceedings of the First Training Workshop on Ethnobotany and its Application to Conservation, September 16-24*. Islamabad: PARC, WWF, ICIMOD. 1996.
60. Nasir S, Ahmed J, Asrar M. Medicinal plants: a promising resource for poverty alleviation in the milieu of Swat. *FUUAST J Biol*. 2014;4:237-245.
61. Shinwari MI, Khan MA. Folk use of medicinal herbs of Margalla Hills National Park, Islamabad. *J Ethnopharmacol*. 2000;69:45-56.
62. Hocking GM. Pakistan medicinal plants 1. *Qual Plant Mat Veg*. 1958;6: 121-136.
63. Hocking GM. Pakistan medicinal plants I. *Qual Plant Mater Veg*. 1958;5: 145-153.
64. Goodman SM, Ghafoor A. The ethnobotany of Southern Balochistan, Pakistan, with particular reference to medicinal plants. *Fieldiana Bot*. 1995;1-V:1-84.
65. Ibrar M, Hussain F, Sultan A. Ethnobotanical studies on plant resources of Ranyal Hills, District Shangla, Pakistan. *Pak J Bot*. 2007;39:329-337.

66. Khattak NS, Nouroz F, Rahman IU, et al. Ethno veterinary uses of medicinal plants of district Karak, Pakistan. *J Ethnopharmacol.* 2015;171: 273-279.
67. Kazim MA, Siddiqui IA. The drug plants of Kalat State. *Pak J Forest.* 1953;217-237.
68. Zaman MB, Khan MS. *Hundred drug plants of West Pakistan.* Peshawar: Medicinal Plants Branch, Pakistan Forest Institute. 1970:1-105.
69. Shodhganga: A Reservoir of Indian Theses. http://shodhganga.inflibnet.ac.in/bitstream/10603/22678/8/08_chapter.pdf.
70. Afridi SK. Medicinal plants of Khyber Agency. M.Sc. Thesis Department of Botany, University of Peshawar. 1986.
71. Farooq S. A review of medicinal plants of Pakistan. *Sci Khyber.* 1990;3: 123-131.
72. Goodman SM, Ghafoor A. The ethnobotany of southern Balochistan, Pakistan with particular reference to medicinal plants. *Fieldiana Bot.* 1992;31:1-84.
73. Haq IU, Hussain M. Medicinal plants of Mansehra District. *Hamdard Medicus.* 1993;34:63-99.
74. Saleem AQ, Kapadia Z, Zahoor S. Naturally occurring insecticides in indigenous plants. *Hamdard.* 1994;37:27-39.
75. Khaliq A. Phytosociological and ethnobotanical studies on plant resources of Dabargai hills. District Swat, Pakistan. M.Sc. Thesis Peshawar: Department of Botany, University of Peshawar. 1995.
76. Marwat Q, Shinwari ZK. Ethnobotanical studies in Upper Siran, Mansehra, Pakistan. In: Shinwari ZK, Khan BA, Khan AA, eds. *Proceedings of the First Training Workshop on Ethnobotany and Its Application to Conservation.* Islamabad: National Herbarium, PARC; 1996. p. 73-82.
77. Ahmad B. Distribution, morphology and medicinal uses of *Taxus baccata* Linn. *Hamdard J Sci Med.* XL:5354.
78. Pitman V. Ethnobotanical research in Margalla Hills. Herbal Gram. *J Am Bot Count.* 2000;51:61-68.
79. Qureshi SJ, Khan MA. Ethnobotanical study of Kahuta from Rawalpindi district Pakistan. *Online J Biol Sci.* 2001;1:27-30.
80. Hamayun M, Khan A, Khan MA. Common medicinal folk recipes of District Buner, NWFP. *Pak J Bot.* 2003;31:56-64.
81. Wazir SM, Dasti AA, Shah J. *J Res Sci.* 2004;15:41-43.
82. Ahmad M, Khan MA, Zafar M, et al. Ethnomedicinal demography and ecological diversification of some important weeds from district Attock-Pakistan. *Pak J Weed Sci Res.* 2006;12:37-46.
83. Ishtiaq M, Khan MA, Ashraf M, et al. An ethnomedicinal survey and documentation of important medicinal plants folklore food phytonims of flora of Samahni valley, District Bhimber, Azad Kashmir, Pakistan. *Asian J Plant Sci.* 2007;10:2241-2256. 649.
84. Hussain K, Shahzad A, Hassnain SZU. *An ethnobotanical survey of important wild medicinal plants of Hattar, District Haripur, Pakistan.* Toba Road Jhang (Punjab), Pakistan: Shaharganj Sugar Research Institute. 2008.
85. Noor MJ, Kalsoom U. Ethnobotanical studies of selected plant species of Ratwal Village, District Attock, Pakistan. *Pak J Bot.* 2011;43:781-786.
86. Qureshi R, Ilyas M, Rahim G, et al. Ethnobotanical study of Bhera, District Sargodha, Pakistan. *J Arch Des Sci.* 2012;65:1661.
87. Qureshi R. Medicinal flora of Hingol National Park, Baluchistan, Pakistan. *Pak J Bot.* 2012;44:725-732.
88. Pervaiz M. Ethnobotanical studies on plant resources of Mangowal, District Gujrat, Punjab Pakistan Avicenna. *J Pytomed.* 2014;4:364-370.
89. Adnan M, Ullah I, Tariq A, et al. Ethnomedicine use in the war affected region of northwest Pakistan. *J Ethnobiol Ethnomed.* 2014;10:16.
90. Khan SM, Ud Din N, Ilyas M, et al. Ethnobotanical study of some medicinal plants of Tehsil Kabal, District Swat, KP, Pakistan. *Med Aromat Plants.* 2015;4:189.
91. Shah AH, Khan SM, Shah AH, et al. Cultural uses of plants among Basikhel Tribe of District Tor Ghar, Khyber Pakhtunkhwa, Pakistan. *Pak J Bot.* 2015;47:23-41.
92. Rahman IU, Ijaz F, Afzal A, et al. Contributions to the phytotherapies of digestive disorders; traditional knowledge and cultural drivers of Manoor Valley, Northern Pakistan. *J Ethnopharmacol.* 2016;192:30-52.
93. Rahman IU, Ijaz F, Iqbal Z, et al. A novel survey of the ethnomedicinal knowledge of dental problems in Manoor Valley (Northern Himalaya), Pakistan. *J Ethnopharmacol.* 2016;194C:877-894.
94. Rahman IU, Ijaz F, Iqbal Z, et al. Graphical dataset on important medicinal plants used for curing dental issues in Manoor Valley, Mansehra, Pakistan. *Data Brief.* 2016;9:1028-1033.
95. Aziz AM, Khan AH, Adnan M, et al. Traditional uses of medicinal plants reported by the indigenous communities and local herbal practioners of Bajaur Agency, Federally Administrated Tribal areas Pakistan. *J Ethnopharmacol.* 2017;10:1-24.
96. Khan K, Shah M, Ahmad H, et al. Exploration and local utilization of medicinal vegetation naturally grown in the Deusai Plateau of Gilgit, Pakistan. *Saudi J Biol Sci.* 2018;26:326-331.